

70th Annual Meeting

of the International Society of Electrochemistry

4 - 9 August 2019
Durban, South Africa

Electrochemistry: Linking Resources
to Sustainable Development



PROGRAM

<http://annual70.ise-online.org>
e-mail: events@ise-online.org

Symposium 3b Fuel Cells, Biofuel Cells and Electrolyzers

Room : 11-CD

Chaired by : *Aleksey Yaremchenko*

09:30 to 09:50

Aleksey Yaremchenko (*Department of Materials and Ceramic Engineering, CICECO - Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal*), Blanca Arias-Serrano, Kiryl Zakharchuk, Jorge Frade

[Composite \$\text{LnNiO}_3\text{+PrO}_x\$ Oxygen Electrodes for Solid Oxide Cells](#)

09:50 to 10:10

Chusheng Chen (*Department of Materials Science and Engineering, University of Science and Technology of China, Hefei, China*)

[Solid oxide electrochemical cells supported on the air electrode with large straight open pores and catalyst-coated surfaces](#)

10:10 to 10:30

Csaba Janaky (*Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary*), Dorottya Hursan, Angelika Samu

[Carbon-dioxide Reduction on N-doped Carbon Electrodes: Structure-activity-stability Relationships.](#)

10:30 to 10:50

Alexander Bagger (*Department of Chemistry, University of Copenhagen, Copenhagen, Denmark*), Jan Rossmeisl

[The electrochemical \$\text{CO}_2\$ reduction reaction: Understanding the selectivity of the Cu catalyst.](#)

10:50 to 11:10 Coffee Break

Symposium 4 Renewable Energy and Photo-Electrochemistry

Room : 22-ABC

Chaired by : *Ladislav Kavan*

09:30 to 09:50

David Fermin (*School of Chemistry, University of Bristol, Bristol, United Kingdom*), Devendra Tiwari

[Bismuth-based Solar Absorbers for Solar Energy Conversion](#)

09:50 to 10:10

Siyabonga Beizel Mdluli (*Chemistry, University of the Western Cape, Cape Town, South Africa*), Morongwa Emmanuel Ramoroka, Suru Vivian John, Emmanuel Iwuoha

[Novel Core-Shell Electroresponsive 3-Dimensional Poly\(propylenethiophenoimine\)-co-Poly\(3,4-ethylenedioxythiophene\) Dendritic Star Copolymers: Synthesis and Photophysical Properties](#)

10:10 to 10:30

Hayelom Hiluf Tesfay (*Chemistry, University of the Western cape, Cape Town, South Africa*), Emmanuel Iwuoha

[Characteristics of \$\text{Cu}_2\text{Zn}_{1-x}\text{FeSnS}_4\$ Nano-crystalline Kesterite Material towards thin Film PV Cell Application.](#)

10:30 to 10:50

Kang Shi (*Department of Chemistry, Xiamen University, Xiamen, China*), Huiqin Hu, Liangliang Zhang, Yanzheng Xu

[Photoelectrochemical Etching for Preparing Ultrasmooth Gallium Nitride Surface in Acidic Electrolyte](#)

10:50 to 11:10

[Coffee Break](#)

Composite $\text{LnNiO}_3+\text{PrO}_x$ oxygen electrodes for solid oxide cells

Aleksey Yaremchenko, Blanca I. Arias-Serrano, Kiryl Zakharchuk, Jorge Frade
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$\text{Ln}_2\text{NiO}_{4+\delta}$ and its derivatives with perovskite-related K_2NiF_4 -type structure demonstrate high mixed ionic-electronic conductivity, moderate thermal and negligible chemical expansion. As a result, these phases attracted significant attention as prospective cathode materials for intermediate-temperature solid oxide fuel cells (IT-SOFC). At the same time, perovskite-like LnNiO_3 has not been considered for these applications, mostly due to the limited phase stability under ambient oxygen pressures. On heating in air, LaNiO_3 decomposes at $\sim 1000^\circ\text{C}$; cathodic polarization can be expected to induce the decomposition of perovskite phase at lower temperatures characteristic for IT-SOFC operation. On the contrary, redox changes imposed by anodic polarization (in solid oxide electrolysis cell mode) under oxidizing conditions should not be of risk for the phase stability of LaNiO_3 . The goal of the present work was the evaluation of LnNiO_3 -based oxygen electrodes for solid oxide fuel/electrolysis cells.

The $\text{LnNiO}_{3-\delta}$ ceramic powders with perovskite-like structure was prepared by glycine-nitrate combustion synthesis followed by calcinations in oxygen atmosphere at $800\text{--}1000^\circ\text{C}$. Porous ceramic samples for electrical and dilatometric studies were sintered in oxygen at $950\text{--}1050^\circ\text{C}$.

Porous $\text{LaNiO}_{3-\delta}$ samples were found to exhibit favorably high p -type metallic-like electrical conductivity, $400\text{--}500\text{ S/cm}$ at $800\text{--}600^\circ\text{C}$ in air. These ceramics demonstrated also a moderate thermal expansion, with average CTE $\sim 13.0\text{ ppm/K}$ at $25\text{--}800^\circ\text{C}$, ensuring thermomechanical compatibility with solid electrolytes.

As a first step, the electrochemical performance of $\text{LaNiO}_{3-\delta}$ electrodes was assessed in contact with three common electrolytes including $(\text{ZrO}_2)_{0.92}(\text{Y}_2\text{O}_3)_{0.08}$ (8YSZ), $\text{Ce}_{0.9}\text{Gd}_{0.1}\text{O}_{2-\delta}$ (CGO10) and $(\text{La}_{0.8}\text{Sr}_{0.2})_{0.98}\text{Ga}_{0.8}\text{Mg}_{0.2}\text{O}_{3-\delta}$ (LSGM). The electrode layers were sintered at 1050°C for 2 h under oxygen flow. The studies of symmetrical cells by EIS demonstrated that the electrochemical activity of $\text{LaNiO}_{3-\delta}$ electrodes increases in the sequence $8\text{YSZ} < \text{CGO10} < \text{LSGM}$; the corresponding values of electrode polarization resistance (R_η) at 800°C were 1.4, 0.8 and $0.25\text{ Ohm}\times\text{cm}^2$, respectively. Significant variations of R_η with electrolyte composition correlate with the extent of chemical reactivity between $\text{LaNiO}_{3-\delta}$ and electrolyte materials during the electrode fabrication.

The R_η values of $\text{LaNiO}_{3-\delta}$ electrodes in contact with LSGM electrolyte were further reduced to $0.03\text{ Ohm}\times\text{cm}^2$ at 800°C and $0.11\text{ Ohm}\times\text{cm}^2$ at 700°C by the surface modification with PrO_x which is known for its electrocatalytic activity. At 750°C and current density of 0.5 A/cm^2 , $\text{LaNiO}_3+\text{PrO}_x$ ($\sim 20\text{ wt.}\%$) electrodes in contact with LSGM solid electrolyte demonstrate the overpotentials of $\sim 60\text{ mV}$ under cathodic polarization and $\sim 40\text{ mV}$ under anodic polarization (Fig.1).

The impact of substitution of lanthanum by praseodymium (in order to improve the chemical compatibility and electrochemical activity) on the relevant properties of LaNiO_3 is briefly discussed.

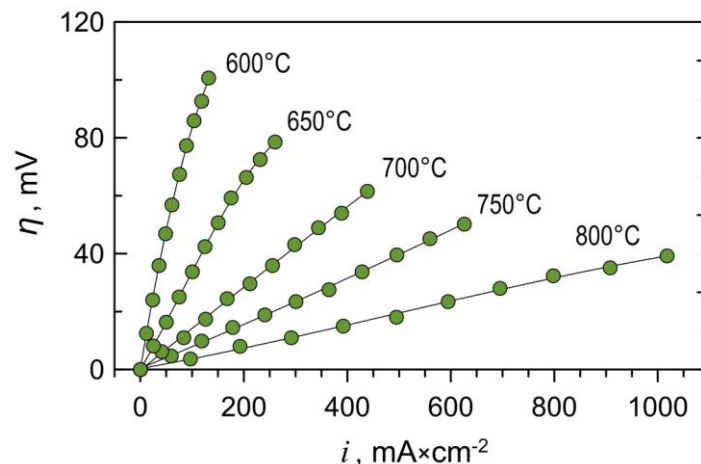


Figure 1. Anodic overpotentials of $\text{LaNiO}_3+\text{PrO}_x$ ($\sim 20\text{ wt.}\%$) electrodes in contact with LSGM solid electrolyte in air.